METHOD AND TESTING DEVICE FOR VERIFYING THE CHARGE INVOICING FOR A COMMUNICATIONS CONNECTION ACCORDING TO TIME-UNIT INTERVALS

The present invention relates to a testing device and a method for verifying the charge invoicing for a communications connection according to time-unit intervals, where a testing device able to simulate at least one calling, analog terminal

5   device and at least one called terminal device is connected to at least one network node that generates time pulses.

Analog telecommunications networks are distinguished in that, inter alia, the charge for a communications connection is calculated according to time-unit intervals. Such charge

10   invoicing is also necessary today in the age of digital communications networks, when analog terminals, such as pay telephones, are used as a calling, terminal device.

In order to be able to determine the price of a communications connection according to time-unit intervals, a switching

15   network node connected to the calling terminal device generates time pulses. The switching network node may transmit the generated pulses to the calling terminal device for the purpose of calculating payment, when it is, e.g. a pay telephone. Each pulse corresponds to a specific monetary

20   value. In each instance, the connection price payable per unit time may be set by selecting the interval of consecutive pulses. The conditions for correctly calculating payment according to time-unit intervals are that

a) the difference between the length of the contractually

25   agreed-upon, time-unit interval and the length of the billed time-unit interval does not exceed a predetermined value, which is, as a rule, less than one second;

b) the first pulse is generated in the network node within a
   predetermined time span after the start of the
   communications connection; and

c) not more than y time pulses are generated after the end of
5 the communications connection, the last time pulse only
   being allowed to be generated within a predetermined time
   span.

Till now, there has been no testing methods and testing
systems, by which the calculation of a connection price
10 according to time-unit intervals may be validated.

Therefore, the present invention is based on the problem of
providing a method and a testing device for verifying the
charge invoicing for a communications connection according to
time-unit intervals.

15 First of all, the present invention solves the problem via the
method steps according to Claim 1.

The method employs a testing device, which may simulate at
least one calling, analog terminal device and at least one
called terminal device and is connected to at least one
20 network node that generates time pulses. The network node is
normally an analog or digital, switching network node. Using
the testing method, at least one predetermined, test-
communications connection may be set up and torn down again in
the network node.

25 First of all, the interval between the start of the test-
communications connection and the generation of a first time
pulse in the network node is determined, and it is checked if
the ascertained interval is within a first predetermined time
domain.

During the existing test-communications connection, time-unit intervals of consecutive time pulses are measured and compared to a predetermined time interval. All of the time-unit intervals occurring between the start and the end of the test-

5   communications connection are advantageously measured.

In addition, it is checked if at least one additional time pulse has been received after the end of the test-communications connection. When this is the case, the time interval between the end of the test-communications connection

10   and the at least one time pulse is ascertained. It is the checked if the ascertained interval is within a second predetermined time domain.

Advantageous further developments constitute the subject matter of the dependent claims.

15   The time interval between the start of the test-communications connection and generation of the first time pulse is measured, using the following steps: The occurrence of a first predetermined event (connect; loop connection), which corresponds to the measurable start of the test-communications

20   connection, is detected at a first predetermined measuring point of the testing device. The reception of the first time pulse of the test-communications connection, which time pulse is generated by the network node, is detected at a second predetermined measuring point of the testing device.

25   A time measurement is started or stopped as a function of the detected occurrence of the first predetermined event (connect; loop connection) and the reception of the first time pulse.

The first measuring point is preferably in the called terminal device, and the second measuring point is preferably in the

30   calling, analog terminal device. The event detected at the first measuring point may be the protocol message "connect" in

the case of a digital, called terminal device, or the event
detected at the first measuring point may be the formation of
a loop connection in the case of an analog, called terminal
device.

5   Since the first and second measuring points are situated away
from the network node, the occurrence of the actual event
"start of connection", which may be at an interface of the
network node, and the recording of the event "start of
connection" detected at the first measuring point are
10   separated in time. In the same manner, the reception of the
first time pulse at the second measuring point and the actual
generation of the first time pulse in the network node are
separated in time. These temporal deviations are referred to
as a systematic measuring error between the location of an
15   actual event and the first or second measuring point that
detects this event. The systematic measuring error is a
function of the chosen test procedure and must therefore be
ascertained for every test scenario.

In order to increase the measuring accuracy of the testing
20   method, the systematic, temporal measuring error between the
location of an actual event, which may be an interface of the
network node, and the predetermined measuring point in
question, which detects this event, is ascertained.

To this end, e.g. the systematic measuring error between the
25   location of the actual occurrence of the start of the test-
communications connection and the first measuring point of the
testing device, and the systematic measuring error between the
location of the actual generation of the first time pulse and
the second measuring point of the testing device, are
30   ascertained. The time interval between the detected occurrence
of the first predetermined event and the reception of the
first time pulse is measured and corrected by the amounts of

the systematic measuring errors. It is then checked if the corrected interval is within the first predetermined time domain.

The time intervals of consecutive time pulses are advantageously measured, using the following steps:

The first time pulse received by the calling, analog terminal device starts a first time measurement; in each instance, each subsequent time pulse arriving at the calling, analog terminal device stops the time measurement, which has been started by the immediately preceding time pulse, and starts a further time measurement. An ith time measurement is started by the last time pulse of the test-communications connection. If the ith time measurement is not stopped by a further time pulse, then this signals the end of the connection-price calculation. In this case, the value of the ith time measurement is discarded. The ith time measurement may then be stopped, for example, after a predetermined time elapses.

Each initiated time measurement for ascertaining the time interval of two consecutive time pulses may be assigned a serial number.

At this point, it should be mentioned that the time measurements may be carried out by software or hardware. In the case of software implementation, the duration of each occurring interval between two time pulses is measured and stored in a storage device. The stored values are then compared to the predetermined time interval. In the case of hardware implementation, e.g. two timers are sufficient, which are each reset to zero after measuring the duration of a time interval, the measured value of the timer in question being written beforehand to a storage device.

Testing methods, which are used in the validation of the calculation of connection prices, must be capable of testing whether time pulses generated after the end of the connection may still occur.

5 To this end, the time interval between the end of the test-communications connection and a first time pulse received after the end of the test-communications connection is ascertained by the following steps:

A time measurement is initiated, when a second predetermined
10 event (disconnect; loop interruption), which corresponds to the measurable end of the test-communications connection, occurs at the first or second predetermined measuring point of the testing device. The number of the currently active time measurement of the temporal spacing of two consecutive time
15 pulses is simultaneously recorded. The time measurement initiated by the second predetermined event is stopped, when the first time pulse is received at the second predetermined measuring point of the testing device after the end of the test-communications connection. The value of this time
20 measurement is compared to the second predetermined time domain, when no further time pulses are received within a predetermined time span.

It should be said that when no time pulses are received after the end of the test-communications connection, the time
25 measurement initiated by the second predetermined event is stopped, for example, after the expiration of a predetermined period of time. In this case, the value of the time measurement is set to "0".

In general, the values of time measurements may only be
30 evaluated, when the measurement of the time intervals of consecutive time pulses is ended. Thus, it is possible for not only one time pulse, but rather several time pulses to occur

after the end of the test-communications connection. The test as to whether these time pulses were allowed to occur is carried out as follows:

The value of the time measurement for the interval between the
5 end of the test-communications connection and the first time pulse received after the end of the test-communications connection, and the values of all time measurements for time intervals of consecutive pulses, whose numbers are greater than the number of the time measurement of the interval of two
10 consecutive time pulses that were active at the end of the connection, are added and compared to the second predetermined time domain.

In addition, the number of time measurements, whose numbers are greater than the number of the time measurement of the
15 interval of two consecutive time pulses, which were active at the end of the connection, may additionally be determined. From this number, it may be determined if the number of time pulses, which have occurred after the end of the test-communications connection, is less than, greater than, or
20 equal to maximum permissible number y of time pulses.

The accuracy of the test method may be improved by more accurately calculating the interval of the actual occurrence of the end of the test-communications connection and the actual generation of time pulses.

25 Therefore, the systematic measuring error between the location of the actual occurrence of the end of the test-communications connection and the first and/or second measuring point of the testing device, as well as the systematic measuring error between the location of the actual generation of time pulses
30 and the second measuring point of the testing device, are measured. The time interval between the occurrence of the second predetermined event (disconnect; loop interruption) and

the reception of a subsequently occurring time pulse is measured and corrected by the amount of the systematic measuring error.

In this manner, it is taken into account that the measuring points are situated away from the network node and that, therefore, the occurrence of the actual event "end of connection", which may occur at an interface of the network node, and the detection of the event "end of connection", are separated in time. In the same manner, the reception of the last time pulse and the actual generation of the last time pulse in the network node occur at different times.

In order to be able to keep the systematic measuring errors small, the first measuring point is determined by the called terminal device, and the second measuring point is determined by the calling, analog terminal device; the test-communications connection also being able to be ended at the two terminal devices.

At this point, it should again be emphasized that a useful objective of the present invention is to calculate as accurately as possible the actual, immeasurable time of the start and end of a test-communications connection, as well as the actual, immeasurable time of the generation of a time pulse.

The above-mentioned problem is additionally solved by the features of Claim 10.

Claim 10 provides a testing device for connection to at least one network node to be tested, which may emit time pulses. The testing device has the following features:
a call simulator for simulating at least one calling, analog terminal device and for simulating at least one further terminal device, which may be operated as a called terminal

device;

a first detector device for detecting time pulses;

a second detector device for detecting a first predetermined
event (connect, loop closure), which corresponds to the

5   measurable start of a test-communications connection;

the first and/or second detector device being designed to
detect a second predetermined event (disconnect; loop
interruption), which corresponds to the measurable end of a
test-communications connection.

10   Additionally provided are a first time-measuring instrument
for measuring, in each instance, time intervals of two
consecutive time pulses;

a second time-measuring instrument for measuring the interval
between the occurrence of the first predetermined event and

15   the reception of the first time pulse of a set up test-
communications connection;

a third time-measuring instrument for measuring the interval
between the occurrence of the second predetermined event and
the reception of at least one time pulse after the measured

20   end of the test-communications connection;

and an evaluation device, which can compare the measured time
spans of the specific time-measuring devices to corresponding,
predetermined time domains. In addition, evaluation device may
check if the number of time pulses occurring after the end of

25   the test-communications connection is less than, greater than,
or equal to predetermined, maximum number y of time pulses.

In order to be able to improve the measuring accuracy of the
testing device, a storage device is additionally provided, in
which the systematic error between the location of the actual

30   start of the test-communications connection and the second
detector device, the systematic measuring error between the
location of the actual end of a test-communications connection
and the first or second detector device, and the systematic

measuring error between the location of the actual generation of time pulses and the first detector device of the testing device are stored. A correction device connected to the storage device is used to correct the values measured by the

5   first, second, and third time-measuring devices by the amount of the respective systematic measuring errors.

In order to be able to test if time pulses received after the end of the test-communications connection may occur, a device, preferably the first time-measuring device, is designed to

10   serially number consecutive time intervals. Furthermore, in response to the numbers assigned to the time intervals, the third time-measuring device can detect if a time interval has been measured in the first time-measuring device after the detection of the second predetermined event (disconnect, loop

15   interruption). For example, the third time-measuring device or evaluation device may add the value for the interval between the end of the test-communications connection and the first time pulse received after the end of the test-communications connection and the values of all of the measured time

20   intervals, whose numbers are, in each instance, greater than the number of the time interval, which has been instantaneously measured in response to the occurrence of the second predetermined event (disconnect; loop interruption) at the first or second detector device of the testing device.

25   In order to keep the systematic measuring errors as small as possible, the first detector device may be assigned to the calling, analog terminal device, the second detector device being able to be assigned to the called terminal device.

The present invention is explained in detail below on the

30   basis of an exemplary embodiment, in conjunction with the attached drawing.

The figure shows an exemplary testing device 10, which includes at least one call simulator 100 that can simulate an analog terminal device 20 as a calling terminal device and a terminal device 30 as a called terminal device. Analog terminal device 20 is connected, via an interface 42, to a switching network node 40 to be tested. Terminal device 30, which is a digital terminal device in the present example, is connected to switching network node 40 via an interface 44. Also conceivable is a test connection, in which terminal device 30 is connected to another switching network node.

Analog terminal device 20 has a detector device 22, which may detect, inter alia, time pulses generated by network node 40. In addition, analog terminal device 20 has a time-measuring device 24, which is implemented in the form of hardware or software and is capable of measuring, in each instance, time intervals between two consecutive time pulses. Schematically represented time-measuring device 24 has, for example, N+1 timers 24_1 through 24_{N+1}, by which N+1 time intervals may be measured. The measured time intervals are each assigned a serial number between 1 and N+1, whose significance is described further down. The time intervals may be stored together with the corresponding number in a memory 26. Analog terminal device 20 may additionally have a generator 29, which generates a loop interruption when a test connection is ended at analog terminal device 20.

Terminal device 30 has a generator 32 for generating an event, which signals the start and possibly the end of a test connection. In the case of a digital terminal device, the protocol message "connect" or "disconnect" is generated as an event, while in the case of an analog terminal device 30, a loop closure or a loop interruption is generated as an event. These events are detected by a detector 34.

Testing device 10 has a further time-measuring device 50, which is connected, for example, to detectors 22 and 34. The interval between the start of a test connection detected at detector 34 and the first time pulse detected at detector 22

5   may be measured by time-measuring device 50.

In addition, a time-measuring device 55 is provided, which can measure the interval between the end of a test connection detected at detector 22 or 34 and a time pulse, which is detected at detector 22 and is generated in network node 40

10   after the end of the test connection. To this end, time-measuring device 55 is connected to detectors 22 and 34. Furthermore, time-measuring device 55 is connected to time-measuring device 24, in order to obtain the numbers of the measured time intervals and, in some instances, the temporal

15   length of particular time intervals.

Stored in a storage device 80 are temporal correction values, which correspond to the systematic measuring errors between interfaces 42 and 44 of network node 40 as locations of the actual events, i.e. generation of time pulses and detection of

20   the start and end of a connection, and to detectors 22 and 34 as a location of the measured events.

A correction device 90 is connected to storage device 26, time-measuring devices 50 and 55, and storage device 80. Since the time intervals measured in time-measuring device 24 and

25   stored in storage device 26 do not have to be corrected, these are simply looped, together with the corresponding number, to an evaluation device 70, via only correction device 70. On the other hand, the values coming from time-measuring devices 50 and 55 are corrected in correction device 90 by the amount of

30   the systematic measuring errors stored in storage device 80, and then transmitted to evaluation device 70.

Evaluation device 70 is also connected to a storage device 60, in which reference values are stored. The reference values correspond to, in particular, the predetermined time-interval length which may be a function of the selected test procedure,

5   a predetermined interval which may be between the actual start of the connection and the generation of the first time pulse, an additional predetermined interval which defines the maximum time interval that may lie between the actual end of the test connection and the last, subsequently generated time pulse, as

10   well as a maximum number y of time pulses which may be generated after the end of the test-communications connection. In addition, another reference value may be stored for a minimum number x of time pulses, which may be generated after the end of the test-communications connection.

15   The method of functioning of testing device 10 illustrated in the figure is explained in detail in the following.

At this point, it is assumed that a test connection should be established from analog terminal device 20 to terminal device 30 via switching node 40. Analog terminal device 20 transmits,

20   inter alia, the call number of terminal device 30 to the network node, which then transmits a ringing signal to terminal device 30. From the received call number, network node 40 ascertains the contractual length of the time intervals, which are relevant to the calculation of the

25   connection costs. The length of this time interval is stored in memory 60 as a reference value for the selected test connection.

In response to the ringing signal, e.g. the lifting of the telephone receiver is simulated in terminal device 30. The

30   protocol message "connect" generated in generator 32 is then transmitted to interface 44 of network node 40. In the present example, the protocol message "connect" is initially detected

in detector device 34, which subsequently initiates a time measurement with the aid of time-measuring device 50.

In response to the reception of the protocol message "connect" at interface 44, network node 40 transmits a first time pulse,

5   the so-called starting pulse, to analog, calling terminal device 20. Detector 22 detects the received starting pulse and stops timer 50. Therefore, the measurement of the time interval between the generation of the protocol message "connect" and the reception of the starting pulse is also

10   ended at analog terminal device 20.

This starting pulse (first counting pulse) may deviate by, at most, a first predetermined time span from the actual start of the connection.

The time interval measured by clock 50 is subject to a

15   systematic measuring error. The reason for the systematic measuring error is that the measuring points, locations in analog terminal device 20 and in terminal device 30, are not the locations of the actual events, for, in the present example, the locations, at which the starting pulse is

20   actually emitted and the start of the connection (reception of protocol message "connect") actually occurs, are interfaces 42 and 44 of network node 40. The time deviation, which is caused by the separation of the locations at which the events actually occur and the measuring points at which these events

25   are measured, represents the systematic measuring error, which is ascertained prior to the start of the test and stored in memory 80. In the present example, the systematic measuring error approximately corresponds to the signal propagation time of the protocol message "connect" from terminal device 30 to

30   network node 40 and the signal propagation time of the starting pulse from network node 40 to analog terminal device 20. Therefore, time-measuring device 50 supplies the measured

time interval to correction device 90, in which the time interval is corrected by the amount of the systematic measuring error.

In evaluation device 70, the corrected interval is compared to the corresponding reference value from memory 60, in order to be able to determine if the time between the two events is, at a maximum, the first predetermined time span.

During the existing connection, network node 40 continually sends time pulses to analog terminal device 20, which are detected by detector 22.

In each instance, the spacing of two consecutive time pulses may not exceed the allowable tolerance. Therefore, the maintenance of this tolerance must be monitored up to the end of the test connection and, in some cases, permanently.

Initially, the starting pulse starts first timer 24_1 of time-measuring device 24, the next time pulse stops first timer 24_1 and starts the second timer, etc., until the last time pulse received during the existing test connection stops timer 24_{N-1} and starts timer 24_N. At the same time, each measured time interval is assigned a serial number. The numbers and the corresponding time intervals are stored in storage device 26. A time pulse following the measured end of the connection stops timer 24_N and starts timer 24_{N+1}. Timer 24_{N+1} may be stopped when, after the end of the test connection, no further time pulse is received within a predetermined time span, which has a length of, e.g. two time intervals. The content of timer 24_{N+1} is then discarded.

The time intervals stored in memory 26 are transmitted uncorrected, together with the corresponding numbers, to evaluation device 70 via correction device 90. Therefore, it is not necessary to correct the length of the time intervals.

The reason for this is that, in the case of this testing device, the systematic measuring error results, on one hand, from the propagation time of the time pulses from network node 40 to analog terminal device 20, and on the other hand, from the processing speed of testing device 10. The result of the two is that, in testing device 10, the event "network node 40 sends time pulse" is only detected with a time delay. This delay may be regarded as constant. Therefore, the measurement of the interval length yields a systematic measuring error of ±0 ms.

Evaluation device 70 compares the measured time intervals to the reference time interval stored in memory 60 and checks if the permissible tolerance is maintained.

Now it is assumed that the test connection is ended at terminal device 30. In this case, the event "telephone receiver hung up" is simulated in terminal device 30. Generator 32 then transmits the protocol message "disconnect" to interface 44 of network node 40. In the present example, the protocol message "disconnect" is detected by detector 34, which consequently starts time-measuring device 55. At the same time, testing device 10 determines number N of currently active timers 24_N.

Two cases are subsequently considered. In the first case, only one time pulse is received in analog terminal device 20, after the protocol message "disconnect" has been generated by generator 32. In the second case, two more time pulses are received in analog terminal device 20, after the protocol message "disconnect" has been generated by generator 32. If more than two time pulses are received in terminal device 20, the method of functioning of the testing device corresponds to the second case.

We will initially discuss the first case.

It is assumed that one more time pulse is detected by detector 22, after the protocol message "disconnect" has been generated by generator 32. In response to the reception of this time pulse, time-measuring device 55 and timer 24_N are stopped, while timer 24_{N+1} is started.

5

The value of time-measuring device 55 corresponds to the interval between the generation of the protocol message "disconnect" and the reception of the one time pulse.

However, this measured interval must still be corrected in

10 correction device 90 by the amount of the systematic measuring error stored in memory 80.

For, as mentioned above, the measuring points in terminal device 20 and in terminal device 30 are not the locations of the actual events "end of connection" and "generation of a

15 time pulse". This is because, in the present example, the locations at which the time pulse is actually emitted and the end of the connection (reception of protocol message "disconnect") actually occurs are interfaces 42 and 44, respectively, of network node 40. The time deviation, which is

20 caused by the separation of the locations at which the events actually occur and the measuring points at which these events are measured, represents a systematic measuring error, which is stored in memory 80. In the present example, the systematic measuring error approximately corresponds to the signal

25 propagation time of the protocol message "disconnect" from terminal device 30 to network node 40 and the signal propagation time of a time pulse from network node 40 to analog terminal device 20.

The corrected value is transmitted, together with number N, to

30 evaluation device 70, where it is compared to the second predetermined time value, in order to be able to determine if the corrected value is less than or equal to the second

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predetermined time value. In addition, evaluation device 70 can also check if the number of time pulses occurring after the end of the test-communications connection is in the interval between x and y.

5 The second case will now be discussed, in which exactly two time pulses are received in analog terminal device 20, after the protocol message "disconnect" has been generated by generator 32.

It is assumed that a first time pulse is detected by detector
10 22, after the protocol message "disconnect" has been generated by generator 32. In response to the reception of this first time pulse, time-measuring device 55 and timer 24_N are stopped, while timer 24_{N+1} is started. In addition, the time interval measured by timer 24_N is assigned serial number N.

15 A second time pulse is detected by detector 22. In response to the second time pulse, timer 24_{N+1} is stopped, and the time interval measured by timer 24_{N+1} is assigned serial number N+1.

Using the serial number of timer 24_{N+1}, time-measuring device 55 may detect that after the protocol message "disconnect" has
20 been generated by generator 32, a complete time interval N+1 has been measured, and the time-measuring device adds this value to the value of time-measuring device 55, which corresponds to the time interval between the generation of the protocol message "disconnect" and the reception of the first
25 time pulse.

The time interval ascertained in time-measuring device 55 is still corrected in correction device 90 by the amount of the systematic measuring error stored in storage device 80, and transmitted, together with number N, to evaluation device 70.

30 Evaluation device 70 checks if the calculated value is less than or equal to the second predetermined time span.

In addition, evaluation device 70 may also check if the number of time pulses occurring after the end of the test-communications connection is in the interval between x and y.

As seen, the number of the currently running timer of time-measuring device 24 must be registered by testing device 10 at the start of timer 55, in order to be able to carry out the described evaluation of the measuring results.

It should be said that the location of the measuring points is preferably selected so as to render the corresponding systematic measuring error as small as possible. Thus, for the above-mentioned example, the measuring point in which the event "start of connection" is detected is located in called terminal device 30. The measuring point, in which the event "end of connection" is detected, is also in the terminal device 30 at which the connection was ended.

List of Reference Numerals

10   testing device

20   calling, analog terminal device

22   detector

24   time-measuring device for measuring time intervals of consecutive time pulses

24_1-
24_{N+1} timer

26   memory in which the measured time intervals are stored together with their numbers

29   generator

30   called terminal device

32   generator

34   detector

40   switching network node

42   interface

44   interface

50   timer for measuring the time span between the start of a test-communications connection and the first time pulse

55   time-measuring device

60   memory in which the predetermined reference values are stored

70   evaluation device

80   memory in which correction values corresponding to the
      systematic measuring errors are stored

90   correction device

100   call simulator